1308-4

BETTER ELEVATOR SERVICE

OTIS ELEVATOR COMPANY
OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD

BETTER ELEVATOR SERVICE

ISSUED IN THE INTEREST
OF ALL WHO OWN, CARE FOR
OR OPERATE ELEVATORS

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Above—The Yonkers, N. Y., Works of the Otis Elevator Company. Other factories are located at Harrison, N. J., Buffalo, N. Y., and Quincy, Ill.

Below—The Otis Building, New York. In this Building are located the General Offices and the Service Warehouse.

A WORD ABOUT OTIS SERVICE

THE supremacy of Otis Elevators—in design, in manufacture and in operating qualities—has been for many years, and is today, universally acknowledged.

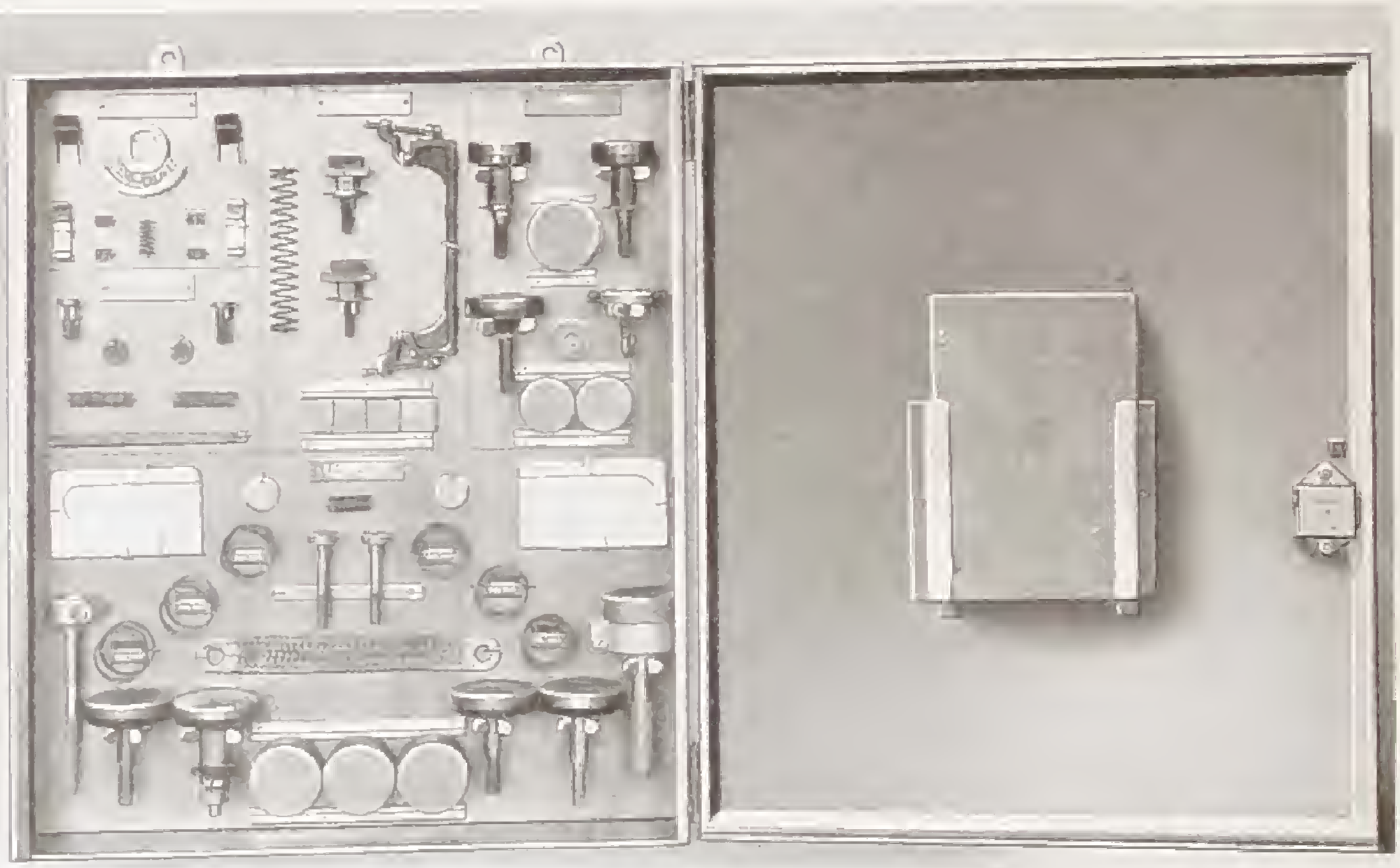
Considered from the standpoint of elevator apparatus generally, Otis Elevators are conceded to need the least amount of mechanical attention. But like any piece of good machinery, they do need proper care and systematic attention if they are to be kept up to their *highest operating efficiency*.

Recognizing its obligation to provide facilities for this care and for the expert inspection of all types of its elevators, everywhere, the Otis Elevator Company some years ago began to establish its own service offices throughout the world. There are *now* over one hundred such offices located in the United States alone, each office carrying in stock all necessary elevator accessories, supplies and parts, ready for immediate shipment.

At these offices one or more factory-trained experts are stationed—men who are thoroughly familiar with elevator construction and operation; and continuous telephone service is maintained in order that these Service men may be reached promptly, at any hour of the day or night, or on Sundays and Holidays.

Periodical inspections can be arranged for with these offices at *nominal rates* under standard contracts providing for weekly, bi-weekly, monthly, bi-monthly or quarterly inspections. Full details of such service will be gladly furnished by the nearest office.

Pages 29 and 30 give the location and present address of all Otis Service Offices in the United States and Foreign Countries.



An Otis Controller Parts Cabinet.

OTIS CONTROLLER PARTS CABINETS

THE Otis Controller Parts Cabinet has been devised to facilitate and quicken repair service in the event of unexpected breakdowns or worn parts on the elevator controller.

It is a compact, shallow box, strongly made of steel and contains all essential emergency wearing parts of the type of Controller furnished with the elevator machine installed.

It is generally hung on the wall of the motor or engine room, so that the engineer in charge, by referring to the descriptive catalogue that goes in the cabinet, can quickly determine the part needed to replace the worn mechanism on the controller and locate instantly that part in the Cabinet.

BETTER ELEVATOR SERVICE

Duplicate parts should be ordered at once to replace the parts removed, so that the Cabinet is at all times complete and ready for other renewals.

With one of these Cabinets in the engine room, minor changes of parts can be made immediately and without impairment of the elevator service.

These Cabinets are now being furnished for practically all the standard types of Otis Controllers. Many of them are listed below.

Any of the Otis Service offices can supply the Cabinet required for your elevator controller.

DIRECT CURRENT

2 DD	Controller	3 FD	Controller
HB	"	6 F	"
AP	"	6 FD	"
HKS	"	MFL 4 B	"
3 F	"	MFL 4 C	"

ALTERNATING CURRENT

2 DA	Controller	2 VAS	Controller
3 DA	"	OVB	"
2 E-AC	"	2 SAS	"
2 VR	"	1-1/2 SS	"
2 VS	"	2 SS	"

ELEVATOR LUBRICATION

EVERY Building Owner, Manager and Engineer is vitally interested in the economical maintenance and proper operation of his elevators. A good many, however, fail to appreciate thoroughly the importance of *proper* lubrication and its direct bearing upon the operating efficiency of the elevators.

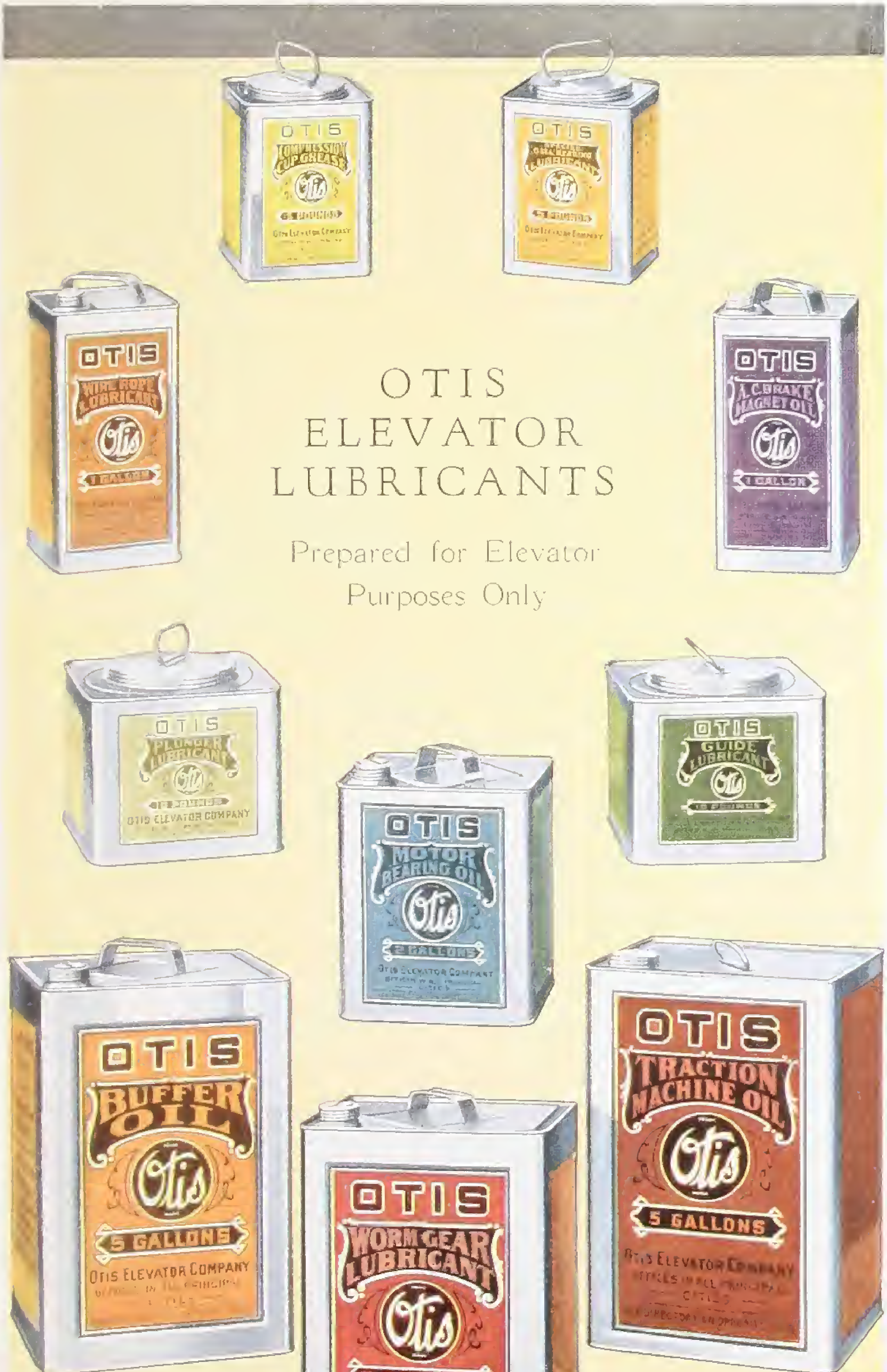
Elevators need special lubrication and special lubricants. While most users do not buy inferior or cheap oils, they frequently obtain oils which are not of the correct constituents for use as applied.

Otis Lubricants are produced with the one idea of supplying *high grade lubricants, strictly for elevator apparatus*—each lubricant compounded for a particular purpose.

There are eleven of these lubricants. They were adopted only after a careful study of what was required and analyses of tests covering a period of years. Long practical experience has proven that these lubricants can be recommended, without reservation, for the exclusive use of elevator operators or owners. A full supply is carried in stock at each Otis Service Office.

The illustration on the opposite page shows the Otis lubricant cans in full color. The can containing each particular lubricant is easily recognizable by the color of its label and this has proved an added convenience in the handling of Otis lubricants.

On Pages 10 to 13 is a more detailed description of each lubricant, its qualifications and its purpose.



OTIS ELEVATOR LUBRICANTS

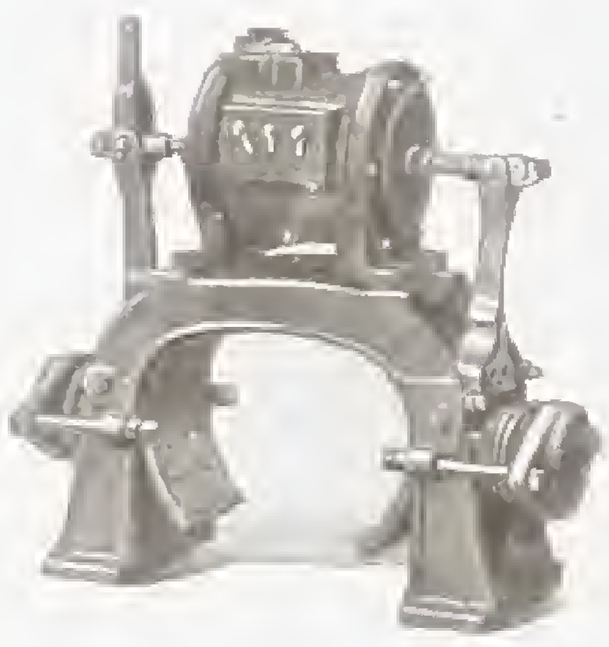
Prepared for Elevator Purposes Only

Ball Bearing Lubricant

A non-corrosive compound free from acid and of a consistency to properly and thoroughly lubricate either slow or high speed ball bearings.

Supplied in five pound cans only.

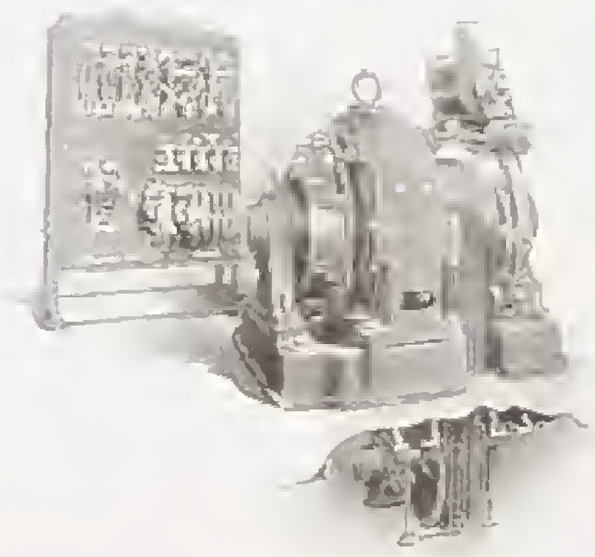
A. C. Brake Magnet Oil



This oil (used in connection with alternating current brake magnets) is for dissipating the heat generated in the brake magnet coil. It is extremely important that this oil be used, as the brake is designed for its use and other oils will gum and stick the core of the magnet, or in other ways vary the speed of the brake plunger. Some cases have been called to our attention where the use of other oils has been the cause of the brake's refusing to release with the current on, with consequent burning out of the motor coils. This oil has superior insulating qualities as well as being free from acid and, therefore, non-corrosive.

Supplied in one gallon and two gallon cans.

Traction Bearing Oil



This oil is used for lubricating the bearings of the gearless traction machines, where solid bearings have been furnished. The regular motor bearing oil should not be used for this purpose, as it has been found to be entirely too light.

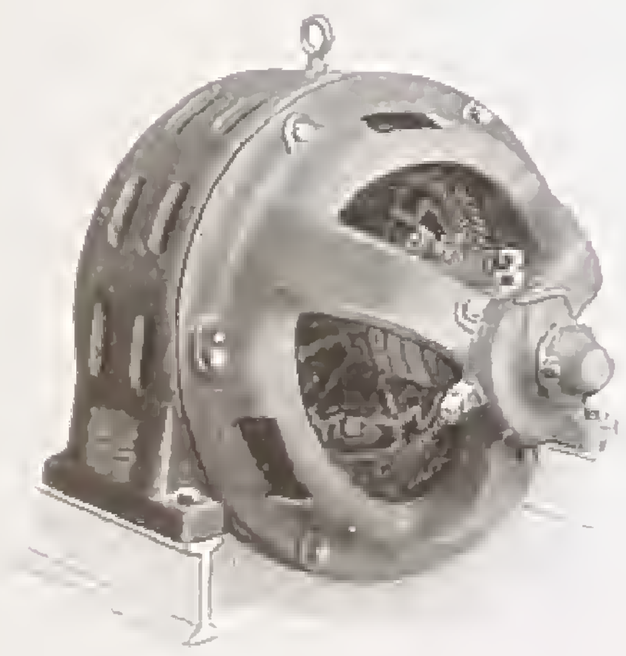
Supplied in two and five gallon cans.

Worm Gear Lubricant

This oil has been found to give the best results for worm gear lubrication. It consists of high grade vegetable castor oil mixed with a mineral cylinder stock. This compounding process is a matter of experiment with most oil retailers and it was only after tests covering a period of several years that Otis Worm Gear Lubricant was developed to a point of proper consistency and quality.

Supplied in two gallon and five gallon cans.

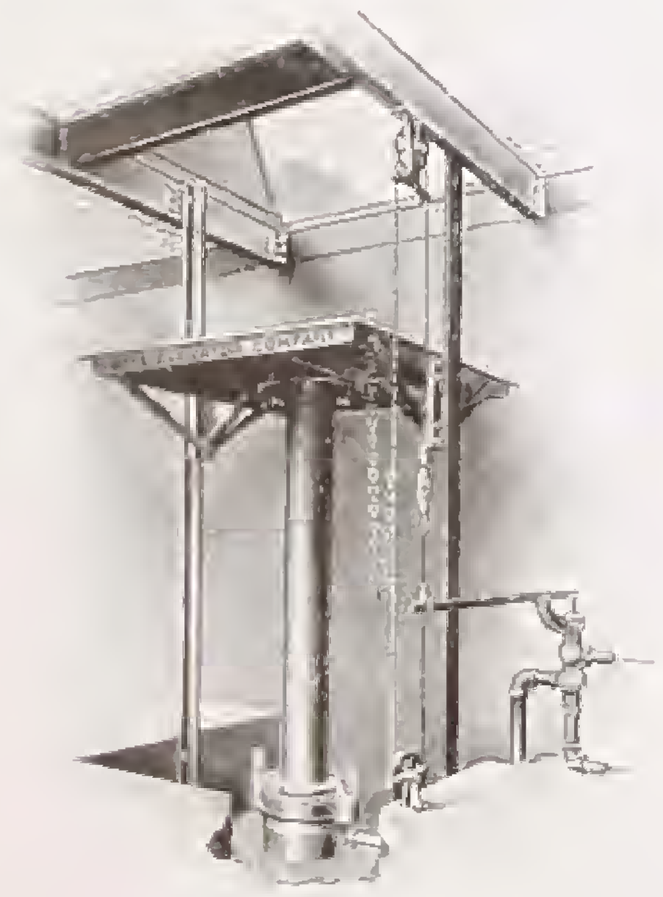
Motor Bearing Oil



An excellent quality of high speed bearing oil. It is used for motor bearings and for small working parts where a light oil is required. This oil will not gum or stick, nor will the heat developed in high speed bearings thicken the oil to make it useless.

Supplied in one and two gallon cans.

Plunger Lubricant



A white grease which has been found very satisfactory for lubricating plungers and the cylinders of horizontal hydraulic elevators.

Graphite plunger grease is sometimes used, but this is not necessary unless the surfaces have become scored or rough.

Supplied in five and ten pound cans.

Guide Lubricant

Particularly desirable for both wood and steel guides, when automatic lubricators are not used. It is less apt to dry or gum than the average lubricant and will not run on the guides.

Supplied in five, ten and twenty-five pound cans.

Compression Cup Grease

A lubricant that is particularly suited for lubricating sheaves and all bearings where grease cups are furnished. It is free from acid and will not harden in the cups.

Supplied in two, five and ten pound cans.

Hydraulic Lubricant

This is a specially compounded soluble oil, being free from acid or other injurious alkali. Will not corrode linings or wearing parts and will materially prolong the life of cup leathers or packings.

To obtain best results, one gallon of this lubricant is used to every one thousand gallons of water. After first charge this proportion can be increased as demands warrant. One charge will lubricate the water for a period of from four to six months, depending upon the service required of the elevators.

Supplied in five gallon cans, half barrels and barrels.

Buffer Oil

This oil has been selected after being found entirely suitable for the purpose. The graduated parts of Otis Buffers have been proportioned for the use of this oil and their successful operation depends upon the circulation of oil through the oil chambers.

It is very essential that buffers be occasionally inspected to ascertain if they are filled with oil, otherwise rust or corrosion affect the operation of the plunger.

Supplied in two gallon and five gallon cans.

Wire Rope Lubricant

A compound especially manufactured for this company and which has been found particularly satisfactory for lubricating and preserving wire ropes. This compound distributes itself throughout the rope and lubricates each individual wire; it also penetrates the core of the rope and serves to prevent moisture from collecting at the core and rusting the internal wires. Only carefully selected oils are used, oils that will neither drip nor gum.

Supplied in one gallon cans.

1	gallon will lubricate	2000	ft.	$\frac{1}{2}$"	Wire Rope
1	" " "	1800	"	$\frac{5}{8}$"	" "
1	" " "	1600	"	$\frac{3}{4}$"	" "
1	" " "	1400	"	$\frac{7}{8}$"	" "
1	" " "	1200	"	1"	" "

All of the above lubricants can also be obtained in barrel and half barrel lots.

INSTRUCTIONS FOR THE CARE AND OPERATION OF DIRECT CURRENT ELECTRIC ELEVATORS

OPEN the main line switch when preparing to clean, oil or adjust any part of the machinery. Keep all parts of the machinery scrupulously clean. A pair of hand-bellows should be used to clean all parts of the apparatus that cannot be conveniently reached. All other parts must be wiped clean.

Always keep the gear case filled to top of worm-shaft. The stand pipe on the side of the gear case should be used to determine if sufficient oil is used. To remove the sediment and grit from gear case, drain oil at least twice a year and wash the housing with kerosene oil. Always refill the housing with fresh oil.

Use only Worm Gear Lubricant for the Worm and Gear.

The motor bearings have automatic feed rings, which should always turn freely and the oil chamber must be kept sufficiently full of oil to insure the oil rings dipping into it.

Use only Otis Motor Bearing Oil for these Bearings.

The worm shaft bearings are automatically oiled from the gear case, and the oil should be allowed to drip slowly through the worm shaft gland to insure perfect lubrication of this bearing. Use drip pan to catch this oil. The worm shaft stuffing box must be kept packed with soft square braided flax packing. The gland adjusting nuts must be tightened evenly to prevent binding of the worm shaft.

Lubricate the drum or sheave shaft bearings every day.

Use only Otis Compression Cup Grease.

The secondary sheave bearing of the worm geared traction machines should be given the same care and attention as the motor bearings; the oiling chains should turn freely and the bearings properly supplied with oil.

Use only Otis Compression Cup Grease.

The governor bearings and gears must be lubricated frequently. The governor pawl bearings should be kept well oiled and should always be perfectly free, so that the pawls will fall against the governor rope when the latch is raised. Keep all pins and moving parts well oiled.

Use only Otis Compression Cup Grease for this purpose.

Keep the compression grease cups on the vibrator sheaves of drum machines filled and sufficiently compressed to feed the lubricant.

Use only Otis Compression Cup Grease for this purpose.

This also applies to sheave bearing boxes of the drum type machines.

The cables on all types of elevators are subjected to varied strains and unusual wear and the lubrication of cables has been a problem not easily solved. Cables on all types of elevator machines should be lubricated to obtain the greatest possible service.

Use only Otis Wire Rope Lubricant for this purpose.

All of the safety devices on the car frame and car should be examined at frequent intervals and all working parts kept clean, well lubricated, and free from rust.

Both wood and steel guides are used for guiding the car and counterweights. Some Engineers have preferred to install automatic lubricators which automatically feed oil on the guides. However, where lubricators are not used, we would recommend the use of *Otis Guide Grease* for this purpose.

Examine the oil buffers under the car and counterweight of traction machines frequently, and be sure that they are filled with oil to height of the pet cock. As these buffers are designed to operate with oil of a certain consistency, it is very necessary to use *Otis Buffer Oil* for proper operation of the buffers.

To prevent sparking at the commutator when adjusting or renewing the brushes, fit them to a full bearing with a strip of fine sand paper; never use emery cloth. This may be done by placing the sand paper between the commutator and the carbons (sand side against the carbon) and drawing it back and forth by hand. The carbons must always project beyond the holders, so that the holder will not bear on the commutator. Brushes should be staggered to distribute the wear evenly on the commutator. The brush springs must be adjusted so as to insure good contact between the carbons and the commutator. In case the commutator becomes rough, it may be smoothed by holding a piece of fine sand paper, never emery cloth, against the surface while the machine is running, after which it should be wiped clean. A canvas pad should always be used for cleaning the commutator; never use waste. Sand papering the commutator should be avoided as much as possible. Polishing them when new with canvas, after being sure that the brushes are at their neutral point and properly bearing on the commutator, brings about

the fine blue finish which improves the commutation. It is most essential to keep commutators free from dirt and oils. This applies to the head of the commutator and the mica insulating ring at the base of the bars, as well as to the surface of the commutator.

Adjust the brake springs to properly hold the load. Set the brake shoes so that they just clear the brake pulley when released. If a piece of thin paper can be passed between the shoes and the pulley, the clearance is sufficient. The brake pulley and brake shoes must be kept clean and dry. Under no circumstances use oil on the brake pulley or brake shoe. Adjust the brake contact on top of the brake magnet casting so that its contacts are sufficiently open to break the arc when the brake is fully released. When necessary to remove the brake shoes for cleaning or repairs, the empty car should be left at the top of the hoistway, with the counterweights securely blocked up in the pit.

Examine the bolts between the drum neck and the drum or driving sheave and tighten them if necessary.

Set the stop collars on the automatic stop switch of the drum machines so that the car will stop at the level of the top and bottom landings with normal loads. The car should be frequently tried on the automatic stop to see if the collars are properly adjusted, as the automatic may be thrown out of adjustment, due to stretching of cables. Remove the cover from the top of the automatic switch on the machine frequently and clean and adjust the contacts.

The contacts on the slack cable switch on the drum machines and of the hatchway limit switches on the drum and traction machines should be frequently cleaned.

Keep the metal and carbon contacts on the controller clean, and free from pits or blisters. They

should be frequently smoothed with sand paper and have a good even bearing when in contact. The springs should also be adjusted to obtain this result. Plungers of magnets should be bright and smooth and should be tried by hand to make sure that they do not stick. Rub a little flaked graphite on these plungers occasionally; never use oil on them.

Oil sparingly the pins and moving parts of the different switches with *Otis Motor Bearing Oil*. See that all nuts, lock nuts and cotter pins are in place and secure. The cover of the car switch should be removed at least once each week to see if the contacts are in good condition and lubricated and adjusted. Keep all parts of the switch clean to prevent dirt accumulating and causing short circuits or burning of the contacts. The small grease pot provided with wick wiper at bottom of car switch should be lubricated with vaseline occasionally, so as to keep the segment clean and lubricated at all times.

OPERATION

LWAYS close the Hatchway Door or Gate securely, before moving the Car Switch.

To start the car move the car switch to the extreme right or left position. The slow speed contacts are intended for stopping only. The up or down magnets on the controller will then make contact and the accelerating contacts will operate to automatically cut out the armature resistance as the speed of the motor increases, and under normal load will all operate within a period of from three to four seconds, if properly adjusted, giving a gradual and easy acceleration of the car to full speed. The accelerating magnets must be set to operate consecutively and at equal intervals.

To stop the car move the car switch slowly toward the center when the car is three or four feet from the landing and finally to the stop position to stop at the landing. It is best not to center the car switch rapidly or reverse it suddenly, inasmuch as this produces unnecessary arcing of the contacts on the controller. A little experience will enable the operator to determine the best way to bring the car to a stop level with the landing, under varying conditions of loading. Always keep the car switch lever in its central position when the elevator is not in service, as it is automatically locked in this position.

In case the Car Switch Centering Spring is broken, it should be immediately replaced.

If the elevator fails to start from the car switch, look for open circuits at the safety switch in the car, main line fuses, operating fuses on the controller, controller contacts, contacts in automatic switch and slack cable switch on drum machines, and governor

switch on traction machines and final hatch limits; also examine all bearings to see if they are dry or hot from lack of oil.

If the elevator fails to stop when the car switch is in the stop position, open the safety switch in the car and if this fails to stop the car, it will be automatically stopped at the top or bottom of hatch by the automatic devices provided for this purpose.

To start a car operated by hand rope or hand wheel, move the hand rope or hand wheel quickly in one direction or the other, so that good contact is assured between the contacts on the controlling device. The operating device should in every case be moved the full limit of its travel to insure good contact.

To stop the elevator, center the hand rope or hand wheel when the car is close to the floor level. If the car fails to start when the hand rope or hand wheel is moved to its proper position, be sure and center the operating device at once and then look for the cause of trouble, as above.

If the car should stop suddenly while descending, throw the car switch on center. Then have the building engineer examine the machine and determine the trouble. If the safety device has operated he should be careful to see that, in case of drum machines, the slack cable is taken up on the safety operating drum under the car and that these cables are not crossed and are in their proper grooves, before releasing the safety device. The hand wrench for releasing the safety device should not be kept in the car, but in the hands of the building engineer or attendant in charge of the elevators. *It is important to remove all kinks from the Governor and Safety Operating Cable. Also to examine the Governor Cable to determine if it has been sufficiently damaged to require the installation of a new cable.*

It is also very important that all slack in the hoisting cables be taken up before the safety is released, as otherwise the car would drop till brought up by the cables, and this fall and sudden stop might snap the cables. This slack is taken up by slowly turning over the machine till the cables are taut. Be sure that the cables go back on the drum in the proper grooves.

Safe Lift Machines are equipped with a locking bar on each end of the safety plank. When these bars are thrown out in their extreme position they engage with clips on the guide rails at each floor. This locking device is operated with a wrench through the corner of the car platform. Before operating the bars, move the car platform a few inches above the desired floor, and by means of the socket wrench throw the bars out in their extreme position. Then lower the car very slowly until the platform comes to rest securely on the clips.

Be sure that the bars have a full bearing on the clips. After loading the safe on the car, raise the car a few inches off the clips, and by means of the socket wrench move the bars to their extreme inward position; be sure that the bars are clear of the clips. Under no circumstances attempt to load a safe or other heavy object on the elevator platform without landing the car platform on the clips as above noted, and after loading the platform do not attempt to lower or raise the load, except as noted, until the bars have been withdrawn and are entirely clear of the clips.

Never attempt to leave the car while it is in motion. Always stop the car at the top and bottom landings with the car switch, the same as at intermediate landings.

INSTRUCTIONS FOR THE CARE AND OPERATION OF ALTERNATING CURRENT ELECTRIC ELEVATORS

ALTERNATING current electric elevators

ALTERNATING current electric elevators are similar in design to the direct current type, excepting that alternating current electrical apparatus is used. The 1:1 gearless traction and the 2:1 rope geared traction machines are not at present being built to operate on alternating current circuits.

The operation of Alternating Current Elevator Machines is the same as noted for Direct Current Machines.

The cleaning of Alternating Current Machines is the same as noted for Direct Current Machines.

The oiling of Alternating Current Machines is the same as noted for Direct Current Machines excepting the Brake. This brake being housed in an oil tight housing, is flooded with oil. It is very important that the brake magnet case be kept well filled with oil. In view of the design and requirements of this brake, it is important to *use only Otis Brake Magnet Oil in this Housing*, otherwise the plunger will become gummed, and stick, and retard the operation of the brake magnet, tending to burn out the brake coil or magnet.

When ordering parts for any part of the elevator, mention the number of the machine as stamped on the Motor Name Plate. Also give Part Number and Name, as is shown in Part Catalogues. When possible give the name of original purchaser.

BETTER ELEVATOR SERVICE

Wearing parts are carried in stock for immediate shipment and all orders will be promptly executed, provided the part desired is fully described or reference made to original numbers. When it is necessary to refer to factory record of original installation, a slight delay in shipment is occasioned.

USEFUL INFORMATION

Area and circumferences of circles within ranges used in general Elevator Practice.

Inches Diameter	Inches Circumference	° in Area	Inches Diameter	Inches Circumference	° in Area
$\frac{3}{4}$"	2.356	.442	30"	94.248	706.86
1"	3.141	.785	32"	100.531	804.25
1 $\frac{1}{2}$"	4.712	1.767	34"	106.814	907.92
2"	6.283	3.14	36"	113.097	1017.90
2 $\frac{1}{2}$"	7.854	4.91	38"	119.381	1134.10
3"	9.424	7.07	40"	125.664	1256.60
3 $\frac{1}{2}$"	10.996	9.62	42"	131.947	1385.40
4"	12.566	12.57	44"	138.230	1520.50
4 $\frac{1}{2}$"	14.137	15.90	46"	144.513	1661.90
5"	15.708	19.63	48"	150.796	1809.60
5 $\frac{1}{2}$"	17.279	23.76	50"	157.080	1963.50
6"	18.850	28.27	52"	163.363	2123.70
6 $\frac{1}{2}$"	20.420	33.18	54"	169.649	2290.20
7"	21.991	38.48	56"	175.929	2463.00
7 $\frac{1}{2}$"	23.562	44.18	58"	182.212	2642.10
8"	25.133	50.26	60"	188.496	2827.40
8 $\frac{1}{2}$"	26.704	56.74	62"	194.779	3019.10
9"	28.274	63.62	64"	201.062	3217.00
9 $\frac{1}{2}$"	29.845	70.88	66"	207.345	3421.20
10"	31.416	78.54	68"	213.628	3631.70
10 $\frac{1}{2}$"	32.987	86.59	70"	219.911	3848.50
11"	34.558	95.03	72"	226.195	4071.50
11 $\frac{1}{2}$"	36.128	103.87	74"	232.478	4300.80
12"	37.699	113.10	76"	238.761	4536.50
12 $\frac{1}{2}$"	39.270	122.72	78"	245.044	4778.40
13"	40.841	132.73	80"	251.327	5026.50
13 $\frac{1}{2}$"	42.412	143.14	82"	257.611	5281.00
14"	43.982	153.94	84"	263.894	5541.80
14 $\frac{1}{2}$"	45.553	165.13	86"	270.177	5808.80
15"	47.124	176.71	88"	276.460	6082.10
16"	50.265	201.06	90"	282.743	6361.70
18"	56.549	254.47	92"	289.027	6647.60
20"	62.832	314.16	94"	295.310	6939.80
22"	69.115	380.13	96"	301.593	7238.20
24"	75.398	452.39			
26"	81.681	530.93			
28"	87.965	615.75			

CABLE			CHAINS (Crane)		
Dia	Breaking Strain in Tons	Weight per Foot	Size	Breaking Strain in Tons	Weight per Foot
	6 x 19 Iron Cable				
3/8"	2.4	.22 lbs.	1/4"	1.70	.75 lbs.
1/2"	3.9	.39 "	5/16"	2.50	1.00 "
9/16"	4.7	.50 "	3/8"	3.60	1.50 "
5/8"	6.0	.62 "	7/16"	5.00	2.00 "
3/4"	8.5	.89 "	1/2"	6.70	2.50 "
7/8"	11.8	1.20 "	9/16"	8.40	3.30 "
	6 x 19 Cast Steel Cable		5/8"	10.30	4.10 "
3/8"	4.8	.22 lbs.	11/16"	12.60	5.00 "
1/2"	8.4	.39 "	3/4"	15.10	6.20 "
9/16"	10.0	.50 "	13/16"	17.60	6.70 "
5/8"	12.5	.62 "	7/8"	20.40	8.35 "
3/4"	17.5	.89 "	15/16"	23.50	9 00 "
7/8"	23.0	1.20 "	1"	26 80	10.50 "
	8 x 19 Cast Steel Cable				
3/8"	4.2	.20 lbs.			
1/2"	7.3	.35 "			
9/16"	8.7	.45 "			
5/8"	10.9	.56 "			
3/4"	15.3	.80 "			
7/8"	20.0	1.08 "			
	Tiller Rope				
3/8"	1.70	.16 lbs.			
7/16"	2.70	.21 "			
1/2"	3.15	.28 "			
9/16"	3.60	.35 "			
5/8"	4.25	.43 "			

Diameter of circle:	Multiply circumference by	.31831
Circumference of circle:	Multiply diameter by	3.1416
Area of circle:	Multiply square of diameter by	.7854
Surface of sphere:	Multiply square of diameter by	3.1416
Cubic inches in sphere:	Multiply cube of diameter by	.5236
Capacity of cylinder in gallons:	Multiply area in inches by length of stroke in inches and divide by 231, the number of cubic inches in a gallon.	
Weight of coal:	One cubic foot of Anthracite coal weighs about 53 pounds.	
Weight of water:	A gallon of water weighs 8.33 pounds; a cubic foot of water weighs 62 pounds.	
Weight of steel bar:	A bar of steel 1 inch square and 1 yard long weighs 10.2 pounds.	

Safe Working Pressure in Cylindrical Shells of Boilers, Tanks, Pipes, etc. in Pounds per Sq. In.

Thick. of steel in 16th inches	Diameter of Cylinder in Inches										
	24	30	36	38	40	42	44	46	48	50	52
1	36.5	29.2	24.3	23.0	21.9	20.8	19.9	19.0	18.2	17.5	16.8
2	72.9	58.3	48.6	46.1	43.8	41.7	39.8	38.0	36.5	35.0	33.7
3	109.4	87.5	72.9	69.1	65.6	62.5	59.7	57.1	54.7	52.5	50.5
4	145.8	116.7	97.2	92.1	87.5	83.3	79.5	76.1	72.9	70.0	67.3
5	182.3	145.8	121.5	115.1	109.4	104.2	99.4	95.1	91.1	87.5	84.1
6	218.7	175.0	145.8	138.2	131.3	125.0	119.3	114.1	109.4	105.0	101.0
7	255.2	204.1	170.1	161.2	153.1	145.9	139.2	133.2	127.6	122.5	117.8
8	291.7	233.3	194.4	184.2	175.0	166.7	159.1	152.2	145.8	140.0	134.6
9	328.1	262.5	218.8	207.2	196.9	187.5	179.0	171.2	164.1	157.5	151.4
10	364.6	291.7	243.1	230.3	218.8	208.3	198.9	190.2	182.3	175.0	168.3
11	401.0	320.8	267.4	253.3	240.6	229.2	218.7	209.2	200.5	192.5	185.1
12	437.5	350.0	291.7	276.3	262.5	250.0	238.6	228.3	218.7	210.0	201.9
13	473.9	379.2	316.0	299.3	284.4	270.9	258.5	247.3	337.0	227.5	218.8
14	510.4	408.3	340.3	322.4	306.3	291.7	278.4	266.3	255.2	245.0	235.6
15	546.9	437.5	364.6	345.4	328.1	312.5	298.3	285.3	273.4	263.5	252.4
16	583.3	466.7	388.0	368.4	350.0	333.3	318.2	304.4	291.7	280.0	269.2

Longitudinal Seams Double Riveted.

Calculated from Formula $P = \frac{14{,}000 \times \text{thickness in inches}}{\text{Diameter in inches}}$

Safety Factor in above table = 5 to 1

Pressure in Pounds per Sq. In. for Different Heads of Water.

Head in Feet	0 Ft.	1 Ft.	2 Ft.	3 Ft.	4 Ft.	5 Ft.	6 Ft.	7 Ft.	8 Ft.	9 Ft.
0	———	.443	.886	1.229	1.732	2.165	2.598	3.031	3.464	3.897
10	4.330	4.763	5.196	5.629	6.062	6.495	6.928	7.361	7.794	8.227
20	8.660	9.093	9.526	9.959	10.392	10.825	11.258	11.691	12.124	12.557
30	12.990	13.423	13.856	14.289	14.723	15.155	15.588	16.021	16.454	16.887
40	17.320	17.753	18.186	18.619	19.052	19.485	19.918	20.351	20.784	21.317
50	21.650	22.083	22.516	22.949	23.382	23.815	24.248	24.681	25.114	25.547
60	25.980	26.413	26.846	27.279	27.712	28.145	28.578	29.011	29.444	29.877
70	30.310	30.743	31.176	31.609	32.042	32.475	32.908	33.341	33.774	34.207
80	34.640	35.073	35.506	35.939	36.372	36.805	37.238	37.671	38.104	38.537
90	38.970	39.403	39.836	40.260	40.702	41.135	41.568	42.001	42.436	42.867

ELECTRICAL FORMULAE

Volt: Unit of pressure.
Ampere: Unit of current flow.
Ohm: Unit of resistance.
Amperes = Volts ÷ Ohms (Ohms law).
Volts x Amperes = watts.
746 watts = one horsepower.
Kilowatt = 1000 watts, known as Kw.
1 mil = .001 inch.

To obtain watts: multiply H. P. by 746
" " H. P.: divide watts by 746
" " H. P.: multiply Kw. by .746
" " Kw.: " H. P. by 1.341

Wires and Wiring

Size of Conductor—let D equal the distance that a current of 1 ampere is to be transmitted and e equal volts drop in the transmission, and I equal current in amperes; then the cross section of the copper conductor in circular mills (c. m.) is found by the formula:

$$\text{c. m. equals } \frac{21.6\ D\ I}{e}$$

Example: to carry 50 Amperes 120 ft. with 5 volts drop would require:

$$\text{c. m. equals } \frac{21.6 \times 120 \times 50}{5}, \text{ this}$$

equals 25920, and upon referring to the table on Page 28 it will be found that No. 6 wire will be required.

The formula applies only to a direct current circuit or to an alternating current circuit where the power factor is unity, or in other words, there is no induction in the circuit.

The wiring table gives data concerning copper wire with safe carrying capacity according to the National Board of Fire Underwriters. The capacity is entirely independent of the voltage drop.

Table of Dimensions, Weights and Resistances—Pure Copper Wire (Bare) Brown & Sharp Gauge. Resistance at 75° F.

Gauge Number	Diameter in inches	Area in Circular Mils (o)	Weight in lbs. per 1000 ft.	Length in feet per Pound	Length in feet per Ohm	Resistance Ohms per 1000 feet	Capacity Amperes Rubber Ins.	Capacity Amperes Other Ins.
X	1.152	1000000	3050.	.3275	95100.	.01051	650	1000
X	1.035	800000	2440.	.4100	76100.	.01313	550	840
X	.963	700000	2135.	.4680	66600.	.01501	500	760
X	.891	600000	1830.	.5460	57100.	.01751	450	680
X	.819	500000	1525.	.6550	47500.	.02101	400	600
X	.728	400000	1220.	.8200	38050.	.02627	325	500
X	.590	250000	762.	1.32	23750.	.04203	240	350
0000	.4600	211600	639.3	1.56	20383.	.04906	225	325
000	.4096	167805	507.0	1.97	16165.	.06186	175	275
00	.3648	133079	402.	2.49	12820.	.07801	150	225
0	.3248	105538	318.8	3.14	10166.	.09838	125	200
1	.2893	83694	252.8	3.99	8062.3	.12404	100	150
2	.2576	66373	200.5	4.99	6393.7	.15640	90	125
3	.2294	52634	159.0	6.29	5070.2	.19723	80	100
4	.2043	41742	126.1	7.93	4021.0	.24869	70	90
5	.1819	33102	100.0	10.00	3188.7	.31361	55	80
6	.1620	26250	79.32	12.61	2528.7	.39546	50	70
7	.1442	20816	62.90	15.90	2005.2	.49871	38	54
8	.1284	16509	49.88	20.05	1590.3	.62881	35	50
9	.1144	13094	39.56	25.28	1261.3	.79281	28	38
10	.1018	10381	31.37	31.38	1000.0	1.0000	25	30
11	.0907	8234	24.88	40.20	793.18	1.2607	23	27
12	.0808	6529	19.73	50.69	629.02	1.5898	20	25
13	.0719	5178	15.65	63.91	498.83	2.0047	17	23
14	.0640	4106	12.44	80.38	395.60	2.5278	15	20
15	.0570	3256	9.84	101.63	321.02	3.1150	—	—
16	.0508	2582	7.81	128.14	248.81	4.0191	6	10
17	.0452	2048	6.19	161.59	197.30	5.0683	—	—
18	.0403	1624	4.91	203.76	156.47	6.3911	3	5

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